FORM PTO-1390 (REV 12-29-99)

U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 32433

U.S APPLICATION NO (If known, see 37 CFR 1 5): 09/508340

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FR98/01954	11 September 1998 (11.09.98)	12 September 1997 (12.09.97)

416 Rec'd PCT/PTO 10 MAR 2000

TITLE OF INVENTION
WIDE AREA MULTI-MODE INTERFEROMETRIC AMPLIFIER WITH RECOMBINER

APPLICANT(S) FOR DO/EO/US
DEVAUX, Fabrice; VERGNOL, Eric

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. [X] A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [ ] is transmitted herewith (required only if not transmitted by the International Bureau).
   b. [X] has been transmitted by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are transmitted herewith (required only if not transmitted by the International Bureau).
   b. [ ] have been transmitted by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [X] A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
    [ ] A SECOND or SUBSEQUENT preliminary amendment.
14. [ ] A substitute specification.
15. [ ] A change of power of attorney and/or address letter.
16. [X] Other items or information:
    Copy of International Search Report.
    Copy of International Preliminary Examination Report.

"Express Mail" mailing label number EL384023845US

Date of Deposit 3/10/00

I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. § 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231.

Paula Almasy
Printed Name of Person Mailing Paper or Fee

Paula Almasy
Signature of Person Mailing Paper or Fee

514 Rec'd PCT/PTO 10 MAR 2000

U.S. APPLICATION NO (if known, see 37 CFR 1.5) 09/508346	INTERNATIONAL APPLICATION NO. PCT/FR98/01954	ATTORNEY'S DOCKET NUMBER 32433

	CALCULATIONS PTO USE ONLY	
17. [X] The following fees are submitted:		
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$970.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$840.00**		
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$690.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$670.00**		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) **$96.00**		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 840.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [X] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$ 130.00	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	20 - 20 =	0	X **$18.00**	$ -0-	
Independent claims	1 - 3 =	0	X **$78.00**	$ -0-	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$260.00**	$ 260.00	
TOTAL OF ABOVE CALCULATIONS =				$ 1,230.00	
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also by filed (Note 37 CFR 1.9, 1.27, 1.28).				$ -0-	
SUBTOTAL =				$ 1,230.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$ -0-	
TOTAL NATIONAL FEE =				$ 1,230.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$ -0-	
TOTAL FEES ENCLOSED =				$ 1,230.00	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of $ 1,230.00 to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 16-0820. A duplicate copy of this sheet is enclosed.
Our Order No. 32433

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO
Michael W. Garvey
Pearne, Gordon, McCoy & Granger LLP
526 Superior Avenue, East
Suite 1200
Cleveland, Ohio 44114-1484

SIGNATURE

Michael W. Garvey
NAME

35878
REGISTRATION NUMBER

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
(National Stage of PCT)

Applicant:	Fabrice Devaux et al.
International Application No.:	PCT/FR98/01954
International Filing Date:	September 11, 1998
Title:	WIDE-AREA MULTI-MODE INTERFEROMETRIC AMPLIFIER WITH RECOMBINER
Docket No.:	32433

PRELIMINARY AMENDMENT "A"

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Please amend the above-identified application, prior to examination thereof, in the following manner.

"Express Mail" number: EL384023845US

IN THE CLAIMS:

1. (amended) [Optical amplification and coupling device of the multimode interference type, the device comprising at least one segment of a multimode wave guide containing an amplifying material to amplify light that propagates in it, characterized in that the amplifying material is contained in a first part of the guide segment in which the light is spatially deconcentrated, a second part of the guide segment in which light is concentrated and which continues beyond the end of the first part being made of a transparent material] A multi-mode interferometric coupler, comprising:

a first amplifying part (2), and

a second transparent part (4) to guide radiation previously amplified in the first part.

2. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 1, wherein the first and second parts [being] are separated by [an interference (6) curved inwards] a curved interface (6).

3. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 1, wherein the first and second parts [being] are separated by a [<<V>>] V-shaped interface (6).

4. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 1, wherein the first and second parts [being] are separated by a zigzag shaped interface (6).

5. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 1, wherein the first and second parts [being] are separated by an inclined interface (6) [along the] on a path of [incoming] input (8) and [outgoing] output (10) rays.

6. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 1, wherein the first and second parts [being placed] are laid out to be approximately perpendicular to [the] a path of [the] an incident beam (8) and an [outgoing] output beam (10).

7. (amended) [Amplification and coupling device] The multi-mode coupler according to any [one] of [the previous] claims 1-6, wherein a single mode guide [being] is placed at [the exit from] an output of the second part.

8. (amended) [Amplification and coupling device] The multi-mode coupler according to [any one of the previous claims,] claim 1, wherein the amplifier material [being] is a structure embedded in an InP substrate.

9. (amended) [Amplification and coupling device] The multi-mode coupler according to [any one of claims 1 to 7, the amplifying material being] claim 1, wherein the amplifying material is a laser material.

10. (amended) [Amplification and coupling device] The multi-mode coupler according to claim 9, wherein the laser material [being] is an InGaAsP quaternary.

11. (amended) [Amplification and coupling device] The multi-mode coupler according to [any one of claims 1 to 7,] claim 1, wherein the amplifying material [having] has quantic wells.

12. (amended) [Optical] An optical amplifier comprising:

[-] an optical pre-amplifier, and

[- an amplification and coupling device] a coupler according to one of claims 1 to 11.

13. (amended) Process for amplifying the power of a light source emitting radiation, consisting of placing [an amplification and coupling device] a coupler according to any one of claims 1 to 11, or an optical amplifier according to claim 12, [on] in the path of the said radiation.

14. (amended) Process [for compensating] to compensate for losses in an optical fiber consisting of placing [an amplification and coupling device] a coupler according to any one of claims 1 to 11, or an optical amplifier according to claim 12, in the path of radiation passing through the optical fiber.

15. (amended) Process for amplification of [wave length multiplexed signals] signals multiplexed in wave length, consisting of increasing the output power using [an amplification and coupling device] a coupler according to one of claims 1 to 11, or an optical amplifier according to claim 12.

REMARKS

If there are any additional fees resulting from this communication not covered by the enclosed check, or if the check was omitted, please charge all uncovered fees to our Deposit Account No. 16-0820, our Order No. 32433.

Respectfully submitted,

PEARNE, GORDON, McCOY & GRANGER LLP

By _____
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WIDE AREA MULTI-MODE INTERFEROMETRIC AMPLIFIER WITH RECOMBINER

DESCRIPTION

Technical domain and prior art

This invention relates to a multi-mode interferometric coupler (MMI coupler), for example for use in a semiconductor amplifier for telecommunications.

The coupler according to the invention may be used for the manufacture of optical components on an InP or AsGa semiconductor (laser, laser modulator, etc.).

One example application is the manufacture of an amplifier outputting an optical power greater than a standard semiconductor amplifier.

Another example application relates to all transmission systems in which a very linear amplifier is necessary.

Multi-mode couplers, and their application to integrated optics, are already known in prior art; examples of couplers and their applications are given in articles by L.B. SOLDANO, Journal of Lightwave Technology, vol. 13, No.4, page 615, 1995 and in the article by P.A. BESSE, Journal of Lightwave Technology, vol. 14, No. 10, page 2290, 1996.

In the field of semiconductor amplifiers, there are standard semiconductor amplifiers and wide area semiconductor amplifiers.

The typical component of a standard semiconductor amplifier is a single mode wave guide on semiconductor, with a core containing a laser type material. When a

current is injected, the material introduces a gain and the lightwave is amplified.

Figures 1A and 1B show the variation of the total power and the maximum power respectively, in the same section of this type of standard semiconductor amplifier. In the example given, a light power of -25dBm is injected, and the total output power is 0 dBm. The maximum power varies in the same way.

Wide area amplifiers can increase the output power of the device by ensuring that the maximum power density does not reach the saturation power level. This saturation power is fixed only by the material and the current. The wave guide is gradually widened to achieve this. Although the wave guide becomes multi-mode, the lightwave remains coupled with the main mode and gradually widens.

The result is that the gain remains the same (25 dB) but the saturation power increases by about 7 dB. Figures 2A and 2B show the variation of the total power and the maximum power respectively, in the same section of a wide area semiconductor amplifier.

This type of device has two disadvantages:

(i) it is difficult to couple output light in a single mode wave guide or in an optical fiber,

(ii) the structure is potentially unstable with respect to a local power modification inducing a variation in the index, which induces coupling of the wave in a higher mode, and another local power modification, etc.

Finally, the paper by K. HAMAMOTO published in EICO'97, on April 2-4 1997, Stockholm, describes an MMI in which all the active material in the coupler is an amplifier.

Description of the invention

Compared with these known devices, the multi-mode interferometric coupler according to the invention comprises two parts, one amplifying part and one part made of a transparent material, which guides the radiation amplified in the first part.

The structure according to the invention can be used to make an amplifier with approximately the same gain and the same saturation power as a wide area amplifier. It also enables coupling of all amplified light in a single mode guide, with minimum losses. Finally, the multi-mode interferometric coupler according to the invention does not have the instability characteristic of a wide area amplifier since, due to its multi-mode nature, the invention is not very sensitive to a fluctuation in the index.

Compared with the device described in the article by K. Hamamoto mentioned above, only part of the multi-mode coupler is used as an amplifier. In the first part of the MMI according to the invention, the optical power is deconcentrated and therefore it is advantageous to amplify the radiation in it. In the second part of the MMI according to the invention, the optical power is concentrated, for example on an output guide, and it is important that it should not be amplified to avoid saturating the amplifier. Therefore, the Hamamoto device does not take advantage of selective amplification in areas in which the optical power is low, unlike the device according to this invention.

Furthermore, the device described by Hamamoto does not use any part made of transparent material, but is simply an amplification device.

A single mode guide may be placed at the output from the coupler according to the invention.

Furthermore, the amplifying material may be a structure embedded in an InP substrate.

The amplifying material may be a laser material, for example a quaternary InGaAsP alloy. This material may also have quantic wells.

The invention also relates to an optical amplifier comprising an optical preamplifier and a coupler according to the invention as described above.

The invention also relates to a number of processes:

- to amplify the power of a light source,
- or to compensate for the losses of an optical fiber,
- or to amplify signals multiplexed in wave length,

these various processes making use of a coupler or an optical amplifier according to the invention.

Brief description of the figures

In any case, the characteristics and advantages of the invention will become clear when reading the following description. This description relates to non-restrictive example embodiments given for explanatory purposes only with reference to the attached drawings in which:

- figures 1A and 1B show the variation in the total power and the maximum power in the same section of a standard semiconductor amplifier,
- figures 2A and 2B show the variation of the total power and the maximum power in the same section of a wide area semiconductor amplifier,
- figure 3 shows the structure of a coupler according to the invention,

- figures 4A and 4B show the variation of the total power and the maximum power respectively, in the same section of a coupler according to the invention,
- figure 5 diagrammatically shows a 1x1 type coupler according to the invention,
- figures 6A to 6D show various boundary shapes between the two parts of a coupler according to the invention,
- figure 7 shows an example of how a coupler according to the invention may be used in an integrated device.

Detailed presentation of embodiments of the invention

Figure 3 diagrammatically shows the structure of a coupler according to the invention. A first part 2 is composed of an amplifying material and is followed by part 4 made of a transparent passive material. In fact, the first part forms an amplifying area (which is typically composed of a laser material) and the second part is a multi-mode guide area composed of a guide material or a laser material polarized to transparency.

The amplifying area and the guide area are laid out to be perpendicular or almost perpendicular to the direction of propagation of incident light 8 and light 10 output from the coupler, to avoid disturbing the coupler's properties.

The device that has been described above is different from other devices with wave guides such as "tapers" or lenses, in that it is composed of a structure with multi-mode guided waves. The incident lightwave is actually coupled on most coupler modes.

Preferably, the shape of the coupler is chosen such that the input light field is reproduced at the output

at one or several locations, with attenuation and a variable phase shift. The conditions necessary to achieve this result are described in the article by L.B. SOLDANO, mentioned above in the introduction to this application.

Figures 4A and 4B show the total power and the maximum power respectively, for a section of a coupler according to the invention, during propagation. In these two figures, the vertical line shows the end of the amplifying structure, or the boundary area 6, between the amplifying structure and the guide material. These figures show that the gain remains equal to 25 dB but that the maximum power is -10 dBm instead of 0 dBm for a standard structure. Therefore, the saturation power is 10 dB higher. Furthermore, light may well be recoupled in a single mode wave guide. The coupler according to the invention does not have the instability characteristic of the wide area amplifier since, due to its multi-mode nature, the coupler according to the invention is not very sensitive to an index fluctuation.

Figure 5 shows an example of a 1x1 coupler, in other words a coupler with an input guide 12 and an output guide 14. Part 2 of the coupler according to the invention is used as an amplifier. The interface between the amplifying medium and the guided area 4 may be vertical. But it may also be slightly inclined (for example at an angle of 2 to 8°) from the vertical in order to avoid reflection problems. The first two corners 16, 18 of the coupler are not necessarily made of an amplifying material since light does not reach these regions.

Other examples of coupler structures according to the invention, and particularly interface couplers between the amplification and guide areas, are shown in

figures 6A to 6D. Figure 6A shows a slightly curved interface area 6. Figure 6B shows a "V" shaped interface area. In figure 6C, it is in the shape of "zigzag". Finally, figure 6B shows an example of a coupler with an interface inclined from the trajectory of incident and emitted beams, or with respect to the vertical (for example with an angle of about 2 to 10° from the vertical).

For example, the amplifying material of a coupler according to the invention may be composed of a structure embedded in InP, an InGaAsP quaternary laser, or quantic wells, with the electrodes and doping system typical of an amplifier, as described in the article by L. B. SOLDANO et al mentioned above. The transparent area may be composed of the same material polarized at a different current, or an InGaAsP material, or quantic energy wells with higher prohibited bands.

Manufacturing techniques for a coupler according to the invention make use of techniques known in prior art. For example, these techniques are described in the book by Y. SUEMATSU et al, entitled "Handbook of semiconductor lasers and photonic integrated circuits", chapter 13, pages 428-458 Chapman & Hall, 1994. Therefore, a structure according to the invention is made using standard wave guide manufacturing methods: embedded ribbon, ribbon at edge, charged ribbon, etc. The amplifier technology is standard (pin structure embedded or at edge). "Butt-coupling" type, selective epitaxy or evanescent coupling integration techniques may be used.

Figure 7 shows an example of how the invention is used in an integrated device, for example in an InP semiconductor. In this device, the first coupler (for

example at 3 dB) of a Mach-Zehnder type device is replaced by a coupler according to the invention.

The device shown in figure 7 comprises (in order from left to right) an input guide 20, an input amplifier 22 (carrying out a pre-amplification step), a coupler 24 according to the invention (in this case a 1x2 diamond shaped coupler with an unequal distribution rate, with one half amplified), two output guides 26, two standard amplifiers 28 and a standard 2x2 coupler 30.

Another example application of the invention is to make an amplifier outputting an optical power higher than a standard semiconductor amplifier. The device according to the invention can then be used as a discrete component, or it may be integrated with other functions on a semiconductor substrate. For example, the device according to the invention may be placed at the output from a laser modulator to increase the optical power level.

In this application, the incident power is already high compared with the pre-amplification function for which the incident power is low. Therefore, the objective of this type of application is to be able to output a high optical power. This type of device can be used in optical telecommunications, for example behind a light source to increase its power level. It may also be used in line to compensate for losses in an optical fiber. In both cases, the advantage of the invention compared with a fiber amplifier doped with erbium (which is traditionally used) is that the amplifier according to the invention may be integrated monolithically with the source in order to form a compact component.

Another example application relates to transmission systems in which a very linear amplifier is necessary. For example, the amplification of signals multiplexed in wave length requires a very linear amplifier to prevent crosstalk between channels. However, semiconductor amplifiers quickly become non-linear; their gain drops above a given optical power level. In this case, the transmission of the device depends on the incident power level, which is the definition of the non-linearity. This may cause various problems in the deformation of optical signals. For example, if an incident signal is composed of lightwaves with several wave lengths, as the light passes through a non-linear device it will cause crosstalk between the various channels. A more linear amplifier could reduce the magnitude of this problem. A typical example is a multi-wave length monolithically integrated source. The device according to the invention can act as an integrated amplifier to increase the output power level.

Another example is an integrated in-line filter device, in which the signal is processed (for filtering and modulation) with optical losses. In this case, adding an amplifier according to the invention can increase the power level without distortion.

Another example is the use of the amplifier to generate the optical signal by spectral turning of the optical field. This is done using the properties of the mix with four semiconductor amplifier waves (for example see the article by T. Ducellier et al entitled "Study of optical phase conjugation in bulk travelling wave semiconductor optical amplifier", published in the IEEE Photonics Technology Letters, vol. 8(4), p. 530 (1996)). A very linear amplifier according to this invention behaves better in this operation than a

conventional semiconductor amplifier, and therefore can advantageously replace it. The efficiency of the mix with four waves is greater when the output power is high, which can be achieved using the amplifier according to the invention.

According to another example, wave length converters are integrated devices including several optical elements such as wave guides, Y-junctions, couplers, semiconductor amplifiers. Very high optical powers are necessary to use them, which is not very practical. Therefore, the invention can advantageously be used as an integrated amplifier by using the same materials as the amplifiers already present on the chip (which are used in this device in any case for their non-linear properties). Due to the different geometry, the same amplifying layer is used as a non-linear or a linear amplifier, which facilitates manufacturing.

English translation of the amended sheets of International Preliminary Examination Report

CLAIMS

1. Optical amplification and coupling device of the multimode interference type, the device comprising at least one segment of a multimode wave guide containing an amplifying material to amplify light that propagates in it, characterized in that the amplifying material is contained in a first part of the guide segment in which the light is spatially deconcentrated, a second part of the guide segment in which light is concentrated and which continues beyond the end of the first part being made of a transparent material.

2. Amplification and coupling device according to claim 1, the first and second parts being separated by an interference (6) curved inwards.

3. Amplification and coupling device according to claim 1, the first and second parts being separated by a «V» interface (6).

4. Amplification and coupling device according to claim 1, the first and second parts being separated by a zigzag interface (6).

5. Amplification and coupling device according to claim 1, the first and second parts being separated by an inclined interface (6) along the path of incoming (8) and outgoing (10) rays.

6. Amplification and coupling device according to claim 1, the first and second parts being placed approximately perpendicular to the path of the incident beam (8) and an outgoing beam (10).

7. Amplification and coupling device according to any one of the previous claims, a single mode guide being placed at the exit from the second part.

8. Amplification and coupling device according to any one of the previous claims, the amplifier material being embedded in an InP substrate.

9. Amplification and coupling device according to any one of claims 1 to 7, the amplifying material being a laser material.

10. Amplification and coupling device according to claim 9, the laser material being an InGaAsP quaternary.

11. Amplification and coupling device according to any one of claims 1 to 7, the amplifying material having quantic wells.

12. Optical amplifier comprising:

- an optical pre-amplifier,
- an amplification and coupling device according to one of claims 1 to 11.

13. Process for amplifying the power of a light source emitting radiation, consisting of placing an amplification and coupling device according to any one of claims 1 to 11, or an optical amplifier according to claim 12, on the path of the said radiation.

14. Process for compensating losses in an optical fiber consisting of placing an amplification and coupling device according to any one of claims 1 to 11,

English translation of the amended sheets of International Preliminary Examination Report

or an optical amplifier according to claim 12, in the path of radiation passing through the optical fiber.

15. Process for amplification of wave length multiplexed signals consisting of increasing the output power using an amplification and coupling device according to one of claims 1 to 11 or an optical amplifier according to claim 12.

ABSTRACT OF THE DISCLOSURE

WIDE AREA MULTI-MODE INTERFEROMETRIC AMPLIFIER WITH RECOMBINER

1. Multi-mode Interferometric coupler comprising:
- a first amplifying part (2),
- a second transparent part (4) to guide radiation previously amplified in the first part.

Figure 3.

FIG. 1A

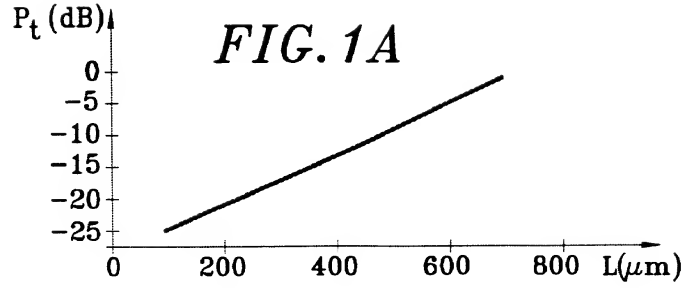


FIG. 1B

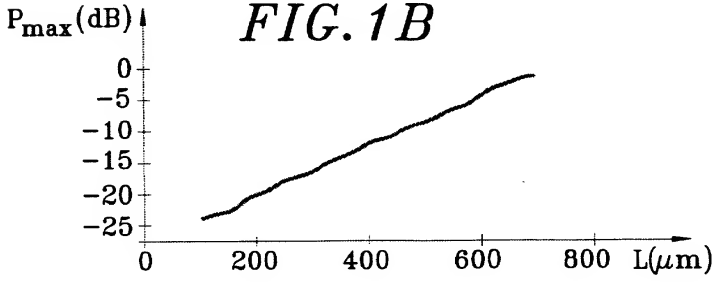


FIG. 2A

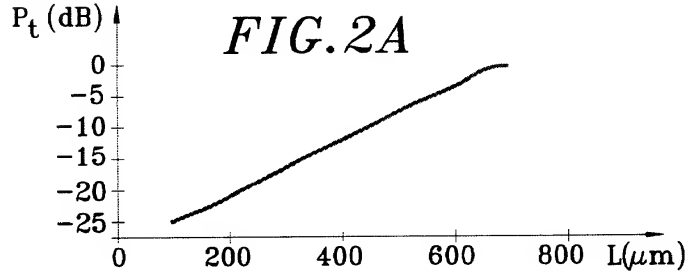


FIG. 2B

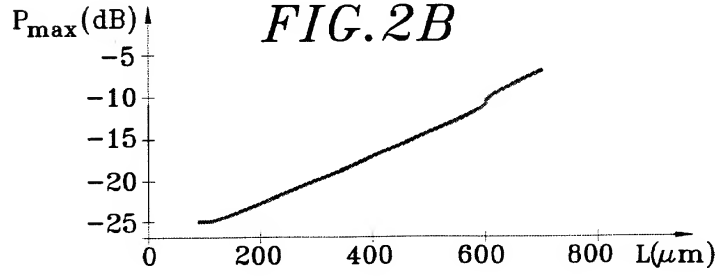


FIG. 3

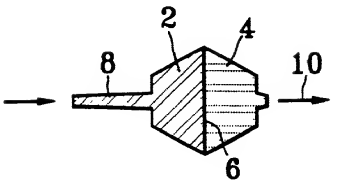


FIG. 5

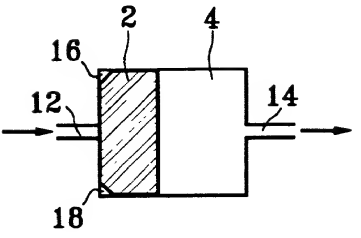


FIG. 4A

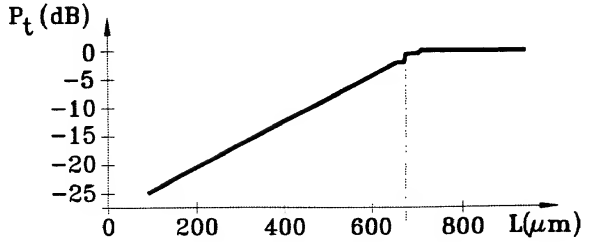


FIG. 4B

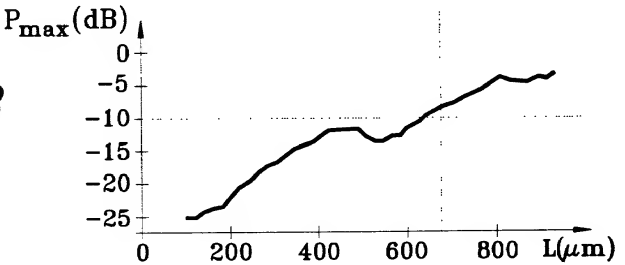


FIG. 7

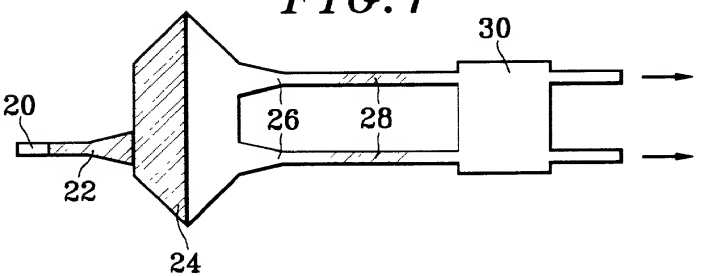


FIG. 6A

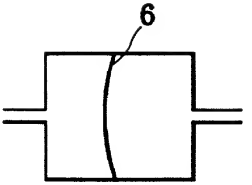


FIG. 6B

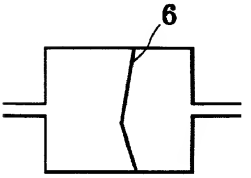


FIG. 6C

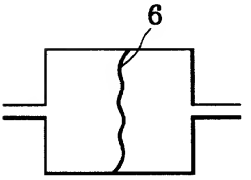
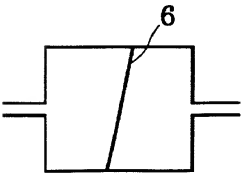


FIG. 6D



SP 14134.C PR

Declaration, Power Of Attorney and Petition

WE (I) the undersigned inventor(s), hereby declare(s) that :

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled
WIDE AREA MULTI-MODE INTERFEROMETRIC AMPLIFIER WITH RECOMBINER

the specification of which

☐ is attached hereto.

☐ was filed on

as Application Serial No.

and amended on

☒ was filed as PCT international application

Number PCT/FR98/01954

on September 11, 1998

and was amended under PCT Article 19

on September 28, 1999

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application (s)

Application No.	Country	Day/month/Year	Priority Claimed
97 11391	FRANCE	12 SEPTEMBER 1997	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

We (I) hereby claim the benefit under Title 35, United States Code, § 119 (e) of any United States provisional application(s) listed below.

(Application Number) (Filing Date)

(Application Number) (Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of prior application and the national or PCT International filing date of this application.

Application Serial No.	Filing Date	Status (pending, patented, abandoned)

And we (I) hereby appoint :Charles B. Gordon, Registration Number 16,923; William C. McCoy, Registration Number 16,885; Louis V. Granger, Registration Number 15,999, William A. Gail, Registration Number 17,409; Richard H. Dickinson Jr, Registration Number 18,622; Thomas P. Schiller, Registration Number 20,677; David B. Deioma, Registration Number 22,841; Joseph J. Corso, Registration Number 25,845; Howard G. Shimola, Registration Number 26,232; Jeffrey J. Sopko, Registration Number 27,676; John P. Murtaugh, Registration Number 34,226; James M. Moore, Registration Number 32,923; David E. Spaw, Registration Number 34,732; Michael W. Garvey, Registration Number 35,878; Paul R. Katterle, Registration Number 36,563; Richard M. Mescher, Registration Number 38,242 and Mark E. Bandy, Registration Number 35,788; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of PEARNE, GORDON, McCOY & GRANGER whose Post Office Address is : 526 Superior Avenue east Suite 1200 Cleveland, Ohio 44114-1484.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true ; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardise the validity of the application or any patent issuing thereon.

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Signature of Inventor

21 MARCH 2000

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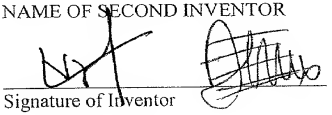
2-cc VERGNOL Eric

NAME OF SECOND INVENTOR



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Date

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NAME OF FOURTH INVENTOR

Signature of Inventor

Date

Residence :

Citizen of :

Post Office Address : The same as residence

NAME OF FIFTH INVENTOR

Signature of Inventor

Date

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Citizen of :

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